

or indirectly by the successive use of two forms of apparatus.

The only difficulty consists in obtaining this heat in such form, or at a thermal potential (*temperature*), which will permit its utilization, or in finding the methods of recuperation^ which will avoid the waste of the energy."

According to these conditions the problem may be stated as follows: *"To find the most advantageous means of transforming energy under any of its various forms, chemical, thermal, electrical, mechanical, etc., either singly or in combination, within the chamber of a furnace, into heat, utilizable for effecting a particular industrial operation."*

All industrial heating operations fall within four principal classes :

" (./) *Those in which the temperature at which the particular reaction occurs is sufficiently low, and the chemical energy of the reaction is sufficient, to release enough heat for the propagation of the reaction and to more than cover all radiation and other cooling effects"*

This case covers the burning of sulphur to sulphur dioxide, the combination of nitrogen with calcium carbide in the manufacture of cyanamide, the making of steel in the Bessemer converter.

" (#) *Those industrial operations in which a certain amount of heat is released, but whose heat energy is not sufficient to maintain the ruling temperature necessary for the reaction"*

This case is the most general one: Nearly all operations release some heat. A characteristic example in this class is the open-hearth furnace.

" (3) *The operation possesses no special chemical energy or is inert."*

This case comprises many reheating and some melting operations.

*"(4) The chemical energy peculiar to the operation is negative."*⁷¹

All the heat must be supplied from an external source.

In translating this work, no effort has been made to transform

the formulas and tables from the metric to the English system, of units. Such a transformation would introduce many complicated constants into the formulas and, in addition, would greatly increase the numerical work required in computation. Moreover,

by translator. — As used here, this does not necessarily mean regeneration, but the economic utilization of the heat by direct or indirect recovery of waste heat.